(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 089 133 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.04.2001 Bulletin 2001/14

(51) Int. Cl.[7]: **G03G 15/08**, G03G 15/00

(21) Application number: **00121028.5**

(22) Date of filing: **27.09.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **01.10.1999 JP 28214299**
18.09.2000 JP 2000282451

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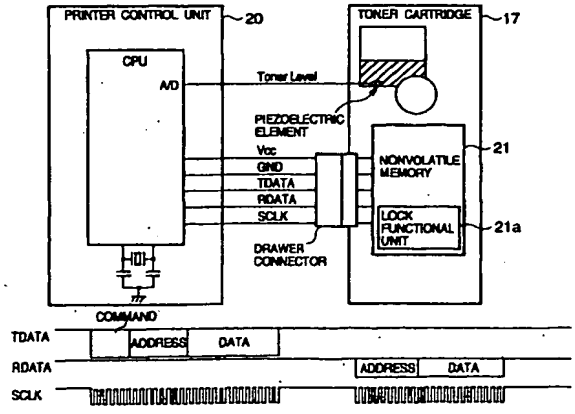
(54) Printing apparatus and its control method, and expendable attached to printing apparatus and having memory

(57) This invention provides a printing apparatus which controls to inhibit any inadvertent write to a memory in an expendable so as to securely manage the exchange timing and the like of the expendable. For this purpose, the expendable such as a toner cartridge or the like comprises a rewritable nonvolatile memory (21) which holds information indicating whether or not its service life has expired. When the toner cartridge is attached to the printing apparatus, it is ready to communicate with a printer engine controller in the printing apparatus, and write to the nonvolatile memory (21) can be made in accordance with an instruction from a control unit. A lock functional unit (21a) writes information indicating write inhibition at a predetermined address in the nonvolatile memory (21), thus inhibiting write to the address position that stores the information indicating whether or not its service life has expired.

FIG. 3



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a printing apparatus and its control method, and an expendable attached to the printing apparatus and having a memory.

BACKGROUND OF THE INVENTION

[0002] Fig. 9 shows the arrangement of a conventional electrophotographic as an example of a printing apparatus of this type.

[0003] Referring to Fig. 9, reference numeral 1 denotes a photosensitive drum for forming an electrostatic latent image; 2, a charging roller for uniformly charging the photosensitive drum 1; 5, an optical unit for generating a laser beam which scans the surface of photosensitive drum 1 upon exposure; 6, a laser beam emitted by the optical unit 5; 3, a developer for developing an electrostatic latent image formed on the photosensitive drum 1, by toner; 4, a transfer roller charger for transferring a toner image on the photosensitive drum 1 onto a predetermined paper sheet; 7, a fixing device for melting and fixing toner on the paper sheet; 8, a standard cassette for storing a stack of paper sheets used in a print process; 9, a standard cassette feed roller for picking up a paper sheet from the standard cassette; 10, a manual insert tray; 11, a manual insert feed roller; 12, exhaust rollers for exhausting the paper sheet outside the apparatus; 13, a registration sensor for registering the leading end of a fed paper sheet in a print process; 14, an exhaust sensor for confirming if a paper sheet has normally been exhausted from the fixing device; 15, a sensor for detecting the presence/absence of paper sheets in the standard cassette; 16, a sensor for detecting the presence/absence of paper sheets to be manually inserted; 17, a toner cartridge (expendable) which integrates the photosensitive drum 1, charging roller 2, developer 3, and toner, and is detachable from the printer main body; 21, a nonvolatile memory mounted on the cartridge; 19, a connector for exchanging signals with the nonvolatile memory 21; and 20, a printer control unit for reading/writing data from/to the nonvolatile memory via the connector.

[0004] In the above arrangement, the nonvolatile memory 21 is mounted in the toner cartridge 17, and a printer engine writes data that pertains to the use state and the like of the cartridge in the memory so as to make control for managing on the basis of written data, e.g., the service life or the like of the photosensitive drum.

[0005] Fig. 10 is a block diagram showing the contents of the printer control unit 20 in Fig. 9 and its peripheries.

[0006] Referring to Fig. 10, reference numeral 101 denotes a printer controller for receiving image data via communications with a host computer, mapping the received image data to information that the printer can print, and exchanging signals with a printer engine controller (to be described below) via serial communications; and 102, an engine controller for exchanging signals with the printer controller via serial communications to control respective units of a printer engine. Reference numeral 103 denotes a paper feed controller for executing paper feed control from when a paper sheet to be printed is fed and conveyed until the paper sheet is exhausted after the print process, on the basis of an instruction from the engine controller 102; 104, an optical system controller for executing drive control of a scanner motor and laser ON/OFF control on the basis of an instruction from the engine controller 102; 105, a high-voltage system controller for executing high-voltage output control required for electrophotographic processes such as charging, development, transfer, and the like on the basis of an instruction from the engine controller 102; 106, a fixing temperature controller for executing temperature control of the fixing device on the basis of an instruction from the engine controller 102, and detecting any abnormality or the like of the fixing device; 107, a paper sensor input unit for transferring information from the paper sensors in the paper feed unit and paper convey path to the engine controller; 108, a jam detector for detecting convey errors during paper convey; and 109, a failure detector for detecting any failure of a functional unit in the printer. Reference numeral 17 denotes the toner cartridge which is detachable from the printer engine, as described above. The toner cartridge 17 has a nonvolatile memory 21 which can exchange data with the engine controller 102, and allows the engine controller 102 to read out or write data. Further, the printer controller 20 corresponds to the engine controller 102 and the other controllers 103 to 109.

[0007] The engine controller 102 reads out or rewrites the memory contents of the nonvolatile memory 21 on the basis of the command of the printer controller 101 or each detecting unit. Note that the rewritable nonvolatile memory uses an EEPROM, but other devices, for example, a flash memory and the like, may be used.

[0008] Fig. 11 shows signals exchanged between the printer control unit 20 and nonvolatile memory 21. The printer control unit 20 includes a CPU, which is connected to the nonvolatile memory 21 in the toner cartridge 17 by serial communication lines via a drawer connector.

[0009] The serial communication lines are formed of TDATA serving as command data to be output from the printer control unit 20 to the nonvolatile memory 21, RDATA serving as return status from the nonvolatile memory 21, and SCLK serving as a sync clock.

[0010] TDATA is issued when the printer control unit 20 reads out the contents of the nonvolatile memory and rewrites its contents, and a read/rewrite instruction

is set using command bits. The read address and rewrite data are output serially. In response to a read command, the nonvolatile memory 21 returns its address and data (may return data alone). In case of a rewrite command, the address and write data are transferred.

[0011] The nonvolatile memory 21 has only a read/write function. For example, it is conceivable that when the printer control unit 20 writes data such as the service life of the toner cartridge 17 or the like, which is important in terms of control, even if that data is inadvertently rewritten due to the influence of some operation errors, it is required to be able to recover the important data. For this purpose, areas where important data is to be written are assigned to a plurality of addresses, and even when the contents of a given area are rewritten, data can be controlled to be recovered or prevented from being lost by reading information at another address.

[0012] However, the method of storing important data upon controlling the printer engine, e.g., data that pertains to the service life of the cartridge, at a plurality of address positions, the nonvolatile memory requires a large capacity and will result in an increase in cost of the system. Furthermore, for obtaining reliable data, data of plurality of address positions must be read out for finding errors, and if an error occurs, the data of subject read corrected by using the plural data is restored.

SUMMARY OF THE INVENTION

[0013] The present invention has been made in consideration of the above problems, and has as its object to provide a printing apparatus and its control method, which control to inhibit any inadvertent write to a memory in an expendable so as to securely manage the exchange timing and the like of the expendable, and an expendable attached to the printing apparatus and having a memory.

[0014] In order to solve the aforementioned problems, for example, a printing apparatus according to the present invention comprises the following arrangement. That is, a printing apparatus to which an expendable having a memory for storing and holding information that pertains to a use state, and a recording agent used in a print process is detachably attached, comprises: memory access means for making read and write to the memory in the expendable; and setting means for setting inhibition/permission of data write with respect to an address space in the memory.

[0015] Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a sectional view showing the structure of a printing apparatus according to the first embodiment of the present invention;

Fig. 2 is a block diagram of a controller and its peripheries in the first embodiment;

Fig. 3 is a view showing the connection relationship between a printer control unit and toner cartridge in the first embodiment;

Fig. 4 shows the internal format of a memory in the toner cartridge in the first embodiment;

Fig. 5 is a flow chart showing the operation processing contents in the first embodiment;

Fig. 6 is a view showing the connection relationship between a printer control unit and toner cartridge in the second embodiment of the present invention;

Fig. 7 is a block diagram of a controller and its peripheries in the third embodiment of the present invention;

Fig. 8 is a view showing the contents of status data from the toner cartridge and their transfer timing in the third embodiment;

Fig. 9 is a sectional view showing the structure of a conventional printing apparatus;

Fig. 10 is a view showing the connection relationship with a conventional toner cartridge;

Fig. 11 is a view showing the connection relationship with a memory in the conventional toner cartridge;

Fig. 12 is a diagram showing the arrangement of a nonvolatile memory and lock functional unit in a toner cartridge in the embodiment of the present invention;

Fig. 13 is a flow chart showing the processing sequence of the lock functional unit; and

Fig. 14 is a flow chart showing the operation processing sequence in a printer control unit in the fourth embodiment of the present invention.

Fig. 15 illustrates a memory map of the non-volatile memory according to the fourth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] The preferred embodiments of the present invention will be described in detail hereinafter with reference to the accompanying drawings.

[First Embodiment]

[0018] Fig. 1 is a sectional view showing the structure of a printing apparatus according to an embodiment of the present invention.

[0019] The same reference numerals in Fig. 1 denote substantially the same parts as in Fig. 9

described previously, and respective building components are as follows.

[0020] Reference numeral 1 denotes a photosensitive drum for forming an electrostatic latent image; 2, a charging roller for uniformly charging the photosensitive drum 1; 5, an optical unit for scanning a laser beam on the surface of photosensitive drum 1; 6, a laser beam emitted by the optical unit 5; 3, a developer for developing an electrostatic latent image formed on the photosensitive drum 1 by toner; 4, a transfer roller charger for transferring a toner image on the photosensitive drum 1 onto a predetermined paper sheet; 7, a fixing device for melting and fixing toner on the paper sheet; 8, a standard cassette for storing a stack of paper sheets used in a print process; 9, a standard cassette feed roller for picking up a paper sheet from the standard cassette; 10, a manual insert tray; 11, a manual insert feed roller; 12, exhaust rollers for exhausting the paper sheet outside the apparatus; 13, a registration sensor for registering the leading end of a fed paper sheet in a print process; 14, an exhaust sensor for confirming if a paper sheet has normally been exhausted from the fixing device; 15, a sensor for detecting the presence/absence of paper sheets in the standard cassette; 16, a sensor for detecting the presence/absence of paper sheets to be manually inserted; 17, a toner cartridge which integrates the photosensitive drum 1, charging roller 2, developer 3, and toner, and is detachable from the printer main body; and 21, a one-chip nonvolatile memory mounted on the cartridge. The nonvolatile memory 21 has a function (lock functional unit 21a shown in Fig. 3) of inhibiting predetermined address contents from being rewritten. The function of the nonvolatile memory 21 will be described in detail later. Reference numeral 19 denotes a connector for exchanging signals with the nonvolatile memory 21; and 20, a printer control unit for reading/writing data from/to the nonvolatile memory via the connector. The printer control unit has a function of writing information indicating the service life of the cartridge has expired in the memory, and setting to inhibit the memory from rewriting that information, when the use amount of the toner cartridge (expendable; to be described later) has exceeded a predetermined value.

[0021] Fig. 2 is a block diagram of the printer control unit 22 and its peripheries in this embodiment.

[0022] Referring to Fig. 2, reference numeral 201 denotes a printer controller for receiving image data via communications with a host computer, mapping the received image data to information that the printer can print, exchanging signals with a printer engine controller (to be described below) via serial communications; and 202, an engine controller for exchanging signals with the printer controller via serial communications to control respective units of a printer engine.

[0023] Reference numeral 203 denotes a paper feed controller for executing paper feed control from when a paper sheet to be printed is fed and conveyed until the paper sheet is exhausted after the print process, on the basis of an instruction from the engine controller 202; 204, an optical system controller for executing drive control of a scanner motor and laser ON/OFF control on the basis of an instruction from the engine controller 202; 205, a toner remaining amount controller for detecting the toner remaining amount in the cartridge, and supplying the detected information to the engine controller 202; 206, a high-voltage system controller for executing high-voltage output control required for electrophotographic processes such as charging, development, transfer, and the like on the basis of an instruction from the engine controller 202; 207, a fixing temperature controller for executing temperature control of the fixing device on the basis of an instruction from the engine controller, and detecting any abnormality or the like of the fixing device; 208, a paper sensor input unit for transferring information from the paper sensors in the paper feed unit and paper convey path to the engine controller 202; 209, a jam detector for detecting convey errors during paper convey; 210, a failure detector for detecting any failure of a functional unit in the printer; and 17, a toner cartridge which is detachable from the printer engine. The toner cartridge 17 mounts the nonvolatile memory 21 which can exchange data with the engine controller, and can read out or write data from or in the engine controller 202. Reference numeral 213 denotes a memory controller which is included in the engine controller 202, and reads out data from the nonvolatile memory 21 and rewrites the contents of the memory 21; 214, a toner use amount detection means which is included in the engine controller 202, and checks the service life of the toner cartridge 17 on the basis of information from the toner remaining amount detector 205 and supplies that information to the memory controller; and 215, a memory lock controller which is included in the memory controller and executes a process for writing service life data in the nonvolatile memory in the cartridge on the basis of service life information from the toner use amount detection means, and inhibiting the memory from rewriting the written data at a predetermined timing. Further, the printer controller 20 corresponds to the engine controller 202 and the all kinds of controller 203 to 210.

[0024] Fig. 3 shows signals exchanged between the printer control unit and nonvolatile memory in this embodiment. The printer control unit includes a CPU, which is connected to the nonvolatile memory in the toner cartridge by serial communication lines via a drawer connector. The toner amount that remains in the developer of the cartridge 17 is detected as an analog value using a piezoelectric element or the like, and that analog value is read from an A/D conversion port of the CPU and is digitally processed.

[0025] The serial communication lines are formed of signal lines of TDATA serving as command data to be output from the printer control unit to the nonvolatile memory, RDATA serving as return status from the nonvolatile memory, and SCLK serving as a sync clock.

TDATA is issued when the printer control unit reads out the contents of the nonvolatile memory and rewrites its contents, and a read/rewrite instruction is set using command bits. The read address and rewrite data are output serially. When data is to be read out from the nonvolatile memory, a command indicating read and an address are issued. In response to this command, the cartridge returns that address and the readout data. When the contents of the memory are to be rewritten, a command indicating rewrite, an address, and rewrite data are transferred.

[0026] The nonvolatile memory 21 in this embodiment has the aforementioned read/write function, and also a function of inhibiting predetermined data from being rewritten (to be referred to as a memory lock function hereinafter).

[0027] Fig. 4 illustrates the address structure in the nonvolatile memory 21 in the cartridge.

[0028] For example, eight address areas are available, and the data width is 8 bits.

[0029] Memory lock to inhibit data write is set on the basis of the data of a specific address in an address space, namely, by writing the predetermined data in an area of address No. 7, the contents of areas of address Nos. 1 to 4 are inhibited from being rewritten. According to the present embodiment, each of areas of address Nos. 1 to 4 is not setup independently. Also, area of address No. 8 setting memory lock of areas of address Nos. 5 to 8, does not allow different setups in units of addresses No. 5 to 8 by writing the predetermined data to address No. 8. Hence, when data is written in address No. 8, the contents of the areas of address Nos. 5 to 8 cannot be rewritten, and the memory lock setups of address Nos. 1 to 4 cannot consequently be changed.

[0030] Upon delivery of the cartridge, the Lot No. of the cartridge is written at address No. 1 in the place of manufacture, and the contents at address Nos. 1 to 4 are locked by the contents at address No. 7.

[0031] On the other hand, when the cartridge is attached to the printer main body, the printer engine accesses the nonvolatile memory 21 at given cycles by the aforementioned toner remaining amount detection means, and writes remaining amount data in an area of address No. 5 indicating the toner remaining amount in the cartridge. At this time, when the toner remaining amount has not reached a predetermined toner remaining amount level at which the service life of the toner cartridge is checked, no memory lock setup is made at address No. 8, and the toner remaining amount level that changes based on the print amount of the printer is rewritten by overwriting the contents at address No. 5 at a predetermined timing, so that the latest remaining amount data can always be stored.

[0032] When it is determined that the toner remaining amount has become equal to or lower than the predetermined level, data indicating that the toner cartridge service life has expired is set at address No. 6, and a memory lock setup is made at address No. 8, thus inhibiting the contents of all the addresses from being rewritten.

[0033] Note that the lock functional unit 21a that permits/inhibits write to the memory using the contents at address Nos. 7 and 8 may be implemented by the following processes.

[0034] For example, upon writing data at address No. 1, a write command, write address, and write data are sent from the engine controller 202 in this order via serial communications. Accordingly, before receiving the data to be written, the write command has been received. Hence, upon receiving the write command, data is read out from addresses Nos. 7 and 8 of the nonvolatile memory 21. Then, it is determined whether or not the read data corresponds to a memory lock setup. For example, if data in the address No. 7 corresponds to a memory lock setup, and if the subsequently received write address signals are one of addresses Nos. 1 to 4, the write address and the data to be written are not passed through. Or else, the write address and the data to be written will be passed through. This process will be accomplished by appropriate logic gate circuits.

[0035] Next, the process of the memory lock control unit 215 is explained. Fig. 5 is a flow chart showing the aforementioned process.

[0036] It is checked in step S1 if the rewrite timing of the toner remaining amount has been reached. This timing is determined by checking if a predetermined timing after, e.g., print processes for 10 pages have been executed, is reached. If the rewrite timing has been reached, the flow advances to step S2 to check by reading data at address No. 6 in the nonvolatile memory if the cartridge service life has expired. If the service life has expired, the subsequent process is canceled.

[0037] If the service life has not expired yet, the flow advances to step S3 to detect the toner remaining amount. A pre-set threshold value is read out from the internal ROM of the engine controller 202 in step S4, and is compared with the detected toner remaining amount in step S5. If it is determined that the toner remaining amount is larger than the threshold value, the detected toner remaining amount is written at address No. 5 in the nonvolatile memory 21, thus ending this process.

[0038] If it is determined that the toner remaining amount is equal to or smaller than the threshold value, it is determined that the service life of the toner cartridge has expired, the toner remaining amount is written at address No. 5 in step S7, and information indicating that the service life has expired is written at address No. 6 in step S8. Furthermore, a memory lock setup is written at address No. 8. With the aforementioned process, data indicating that the service life of the toner cartridge has expired can be temporarily memory-locked. [Modified Example]

[0039] The lock functional unit 21a of the nonvolatile memory 21 in the toner cartridge 17 can be imple-

mented by the aforementioned appropriate gate circuit, but they can also be implemented by a processor using software. Also, an example of the arrangement and processing sequence in such case will be explained below.

[0040] The lock functional unit 21a is implemented by a processor 120, as shown in Fig. 12. The processor 120 comprises a program memory (ROM and RAM) which stores a program of that operation process, and is also used as a simple work memory. The processor 120 is connected to the memory element 21b of the nonvolatile memory 21 via an 8-bit bus and 3-bit address bus, and read and write signal lines are connected therebetween.

[0041] The operation process sequence of the processor 120 will be explained below with reference to the flow chart in Fig. 13. A power supply required for operating the processor 120 uses a Vcc signal from the printer control unit.

[0042] In step S11, the control waits for TDATA received from the printer control unit 22. Upon receiving TDATA, the flow advances to step S12 to determine by checking the first command of TDATA if TDATA is a write or read instruction. If it is determined that TDATA is a read instruction, the flow advances to step S13 to output the address (one of 0 to 7) contained in TDATA to the nonvolatile memory 21 and also output a read signal, thus reading out data at the corresponding address. The designated address and readout data are returned to the printer control unit 22 as RDATA. The reason why not only data but also the address are returned is that the printer control unit 22 can check if the data is the one at the designated address.

[0043] If it is determined in step S12 that the received TDATA contains a write instruction command, the flow advances to step S15. In step S15, data at address Nos. 7 and 8 of the nonvolatile memory 21 are read out. It is checked in step S16 if the write address position contained in TDATA is a write inhibition position. If that address position is a write permission position, the flow advances to step S17 to write the write data contained in TDATA at the designated address position. The data at the write address position is read in step S18, and the write address and data read out from that write address are returned as RDATA to the printer control unit 22 in step S19. As a result, the printer control unit 22 can check if data is normally written, since the write address and data written at that address are returned.

[0044] If it is determined in step S16 that the received TDATA contains a write instruction command, and the write address position is a write inhibition position, the process in step S17 is skipped, and the processes in steps S18 and S19 are executed. That is, data at the address where write might be made is read, and the write address and read data are returned as RDATA.

[0045] As a result, when the printer control unit 22 outputs TDATA to read or write data, the address and data are returned from the toner cartridge in either case.

[Second Embodiment]

[0046] The second embodiment will explain a case wherein a wireless communication function is used between the nonvolatile memory 21 and printer control unit 20.

[0047] Fig. 6 shows the interface between the printer control unit 20 and a wireless memory.

[0048] Toner level detection is done in the same manner as in the first embodiment.

[0049] In the second embodiment, the interface between the nonvolatile memory 21 and printer control unit 20 has a wireless arrangement, i.e., has no electrical contacts. For this reason, the read/write driver circuit 20a is mounted in the printer control unit 20 and it is connected to the coil antenna 20b. The cartridge has an antenna 21b in coil-shape, which is connected to the nonvolatile memory21 and is located at a position opposite to the antenna 20b when attaching to the printer. The communication is established by electromagnetical coupling between antenna 20b and 21b.

[0050] In principle, magnetic field generated by flowing a predetermined modulated current to the coil 20b causes electric power on the coil 21b connected to the nonvolatile memory 21. The memory operates by that electric power. The current which flows on the printer controller 20 side undergoes amplitude modulation at a modulation factor of around 10% with respect to the carrier amplitude, and data is sent to the memory 21 by that modulation. The memory 21 determines data to be returned on the basis of the received data, and digitally switches the impedance of the coil 20b connected thereto. The change in impedance changes the electromagnetic coupling coefficient with the coil 20b on the printer control unit 20 side, and the read/write driver circuit on the printer control unit 20 side detects the change so that the contents of the memory can be received.

[0051] The read/write driver circuit 20a and the CPU of the printer controll unit 20 are coupled via clock-synchronized serial communications. That is, the read/write driver circuit 20a generates a modulated current or the received data of the serial communication with the CPU, so it has a function of converting the change in impedance received from the memory 21 into a protocol of the serial communication with the CPU.

[0052] The contents of the storage memory and the like are the same as those in the first embodiment, and the memory lock process can provide the same effect as described above even when the memory is of wireless type.

[Third Embodiment]

[0053] The third embodiment will explain a case

wherein memory lock setups for inhibiting memory rewrite are made in accordance with an instruction from the printer controller in place of determination by the engine controller.

[0054] Fig. 7 is a block diagram showing the interface between the engine controller and printer controller, and that with the memory.

[0055] Referring to Fig. 7, reference numeral 301 denotes a printer controller for receiving image data via communications with a host computer, mapping the received image data to information that the printer can print, and exchanging signals with a printer engine controller (to be described below) via serial communications. The printer controller 301 has a function of displaying a message on a display panel when it is determined based on the serial communication contents from the engine controller that the use amount of the toner cartridge has exceeded a predetermined value, thus informing the user that the service life has expired. Also, the printer controller 301 has a function of asking the user via the display panel if the cartridge is exchanged, and sending a memory lock instruction to the engine controller when the user instructs to exchange the cartridge.

[0056] Reference numeral 302 denotes an engine controller for exchanging signals with the printer controller 301 via serial communications to control respective units of a printer engine.

[0057] Reference numeral 303 denotes a paper feed controller for executing paper feed control from when a paper sheet to be printed is fed and conveyed until the paper sheet is exhausted after the print process, on the basis of an instruction from the engine controller; 304, an optical system controller for executing drive control of a scanner motor and laser ON/OFF control on the basis of an instruction from the engine controller 302; 305, a toner remaining amount controller for detecting the toner remaining amount in the cartridge, and supplying the detected information to the engine controller 302; 306, a high-voltage system controller for executing high-voltage output control required for electrophotographic processes such as charging, development, transfer, and the like on the basis of an instruction from the engine controller 302; 307, a fixing temperature controller for executing temperature control of the fixing device on the basis of an instruction from the engine controller 302, and detecting any abnormality or the like of the fixing device; 308, a paper sensor input unit for transferring information from the paper sensors in the paper feed unit and paper convey path to the engine controller 302; 309, a jam detector for detecting convey errors during paper convey; and 310, a failure detector for detecting any failure of a functional unit in the printer.

[0058] Reference numeral 311 denotes a toner cartridge which is detachable from the printer engine in the third embodiment. This toner cartridge mounts a nonvolatile memory 312 which can exchange data with the engine controller 302, and allows the engine controller 302 to read out or write data.

[0059] Reference numeral 313 denotes a memory controller which is included in the engine controller 302, and reads out data from the nonvolatile memory 312 and rewrites the contents of the memory 312; 314, a toner use amount detection means which is included in the engine controller 302, and checks the service life of the toner cartridge on the basis of information from the toner remaining amount detector 305 and supplies that information to the memory controller 313; and 315, a memory lock function which is included in the memory controller 313 and executes a process for writing service life data in the nonvolatile memory in the cartridge on the basis of service life information from the toner use amount detection means 314, and inhibiting the memory from rewriting the written data at a predetermined timing.

[0060] Reference numeral 316 denotes a display controller which displays a message on the display panel upon receiving service life information of the toner cartridge from the engine controller 302, and asks the user if the toner cartridge is exchanged; and 317, a serial communication controller for sending a memory lock instruction of the memory contents to the engine controller when the user inputs "yes" in response to the inquiry about exchange of the cartridge.

[0061] Fig. 8 shows the serial communication between the engine controller 302 and printer control unit and return status from the engine controller 302.

[0062] When a toner cartridge service life expire bit is set, the controller 301 informs the user of the service life via the display, and confirms the presence/absence of exchange, as described above. Upon receiving a reply that instructs exchange via a switch on a control panel or the like, the controller sends a memory lock instruction of the memory contents to the engine controller 302.

[0063] Note that the present invention is applied to a printer connected to a host computer. However, the present invention is not limited to such specific apparatus, but may be applied to a printing unit of a copying machine, facsimile, and the like.

[0064] In this embodiment, a toner cartridge has been exemplified as an expendable. However, the present invention is not limited to this. For example, in case of an ink-jet printing apparatus, the present invention may be applied to an ink cartridge, and the present invention is not limited by such expendables.

[0065] As described above, according to this embodiment, since a recording medium such as a memory, which is characterized in that when an expendable including the recording medium has reached a predetermined condition, write to a predetermined area is inhibited in accordance with an instruction from a printer controller, and the write inhibition state is also inhibited from being changed, is used, security of important control data can be improved without increasing the mem-

ory size unlike in the prior art, resulting in improved quality of the printer system and a cost reduction.

[Fourth Embodiment]

[0066] The fourth embodiment will explain a case wherein data in a plurality of areas of the memory in the toner cartridge are locked at different timings under a plurality of conditions.

[0067] Areas to be locked as a printer include a bit indicating whether or not the cartridge is a new one, toner LOW, toner OUT, and initial installation date data as shown in Fig. 15.

[0068] These data are sequentially locked depending on the following use conditions.

1. When a new cartridge is installed in the engine main body, the controller reads the "new cartridge bit" in the cartridge memory, and instructs the engine to write the "initial installation date" data if the read data is "01h".
2. Upon receiving a write request of an "initial installation date" data from the controller, the printer control unit rewrites the contents at the address containing the "new cartridge bit" in the nonvolatile memory of the toner cartridge from "01h" to "00h" so that sets the 1st bit of the address FFh to "new cartridge bit" and locks that bit.
3. The printer control unit then writes the "initial installation date" data at the corresponding address position of the nonvolatile memory so that sets the 2nd bit of the address FFh to "1" to "initial installation date", and locks that data.
4. After that, when the printer is used and the toner remaining amount has reached a predetermined remaining amount N%, the printer control unit writes "toner LOW" data and locks that information by setting a "1" to the 3rd bit of the address FFh.
5. When the toner cartridge is further used and the toner remaining amount has reached M% smaller than N%, the printer control unit writes "toner OUT" data and locks that information by turning "1" to 4th bit of the address FFh.

[0069] In this way, data in a plurality of areas are locked at different times under different conditions.

[0070] Fig. 14 is a flow chart showing the operation processing sequence of the printer control unit in the fourth embodiment. For the sake of simplicity, the printer control unit and expendable (toner cartridge) have the same arrangement as that shown in Fig. 3 or Fig. 6.

[0071] In step S21, the presence/absence of a toner cartridge 17 is checked. If it is determined in step S22 that a toner cartridge 17 is attached, the flow advances to step S23. In step S23, data at the address indicating if the cartridge is a new one in the nonvolatile memory of the toner cartridge is read out, and it is checked if the readout data is "1". This checking step is achieved by issuing TDATA and receiving RDATA. If it is determined that the toner cartridge is a new one, the flow advances to step S24 to write today's date at the address position in the nonvolatile memory where "initial installation date" is stored. In step S25, "0" is written at the address position indicating a new cartridge. The flow then advances to step S26 to lock the address of "initial installation date". In order to lock the address, data is set at an address that manages write permission at the address of "initial installation date".

[0072] The flow then advances to step S27 to detect the toner remaining amount of the toner cartridge. If it is determined that the detected remaining amount is equal to or smaller than N%, "1" is written at the address position in the nonvolatile memory, which indicates that the remaining amount has reached N% or less, and that address position is locked.

[0073] In steps S30 to S32, if it is determined that the toner remaining amount of the toner cartridge has become M% or less (M < N), "1" is written at the address in the nonvolatile memory, which indicates toner OUT, and that address is locked.

[0074] As described above, according to the present invention, control is made to inhibit inadvertent write to a memory in an expendable, thus securely managing the exchange timing or the like of the expendable.

[0075] As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

[0076] This invention provides a printing apparatus which controls to inhibit any inadvertent write to a memory in an expendable so as to securely manage the exchange timing and the like of the expendable. For this purpose, the expendable such as a toner cartridge or the like comprises a rewritable nonvolatile memory (21) which holds information indicating whether or not its service life has expired. When the toner cartridge is attached to the printing apparatus, it is ready to communicate with a printer engine controller in the printing apparatus, and write to the nonvolatile memory (21) can be made in accordance with an instruction from a control unit. A lock functional unit (21a) writes information indicating write inhibition at a predetermined address in the nonvolatile memory (21), thus inhibiting write to the address position that stores the information indicating whether or not its service life has expired.

Claims

1. A printing apparatus to which an expendable having a memory for storing and holding information that pertains to a use state, and a recording agent used in a print process is detachably attached, comprising:

memory access means for making read and write to the memory in the expendable; and

setting means for setting inhibition/permission of data write with respect to an address space in the memory.

2. The apparatus according to claim 1, wherein said memory access means and the memory are connected via a serial communication line.

3. The apparatus according to claim 1, wherein said memory access means and the memory are connected via non-contact communication means.

4. The apparatus according to claim 1, further comprising:

detection means for detecting an amount of an expendable agent in the expendable; and

expendable agent update means for writing the expendable agent amount detected by said detection means at a predetermined address position of the memory via said memory access means, and

wherein said setting means sets to inhibit write to the predetermined address position when said detection means detects that the remaining amount of the expendable agent becomes not more than a predetermined amount.

5. The apparatus according to claim 1, wherein one or a plurality of predetermined amounts of the expendable agent are determined in advance, when each of the predetermined amounts has been reached, data indicating that the predetermined amount has been reached is written in an address area corresponding to that predetermined amount at a different timing, and write to the address area is set to be inhibited.

6. The apparatus according to claim 1, wherein the memory in the expendable includes a management address area which stores information indicating whether or not write to an address that stores the use state is permitted, and said setting means sets data stored at the management address.

7. A printing apparatus comprising:

detaching/attaching means for detaching or attaching an expendable having a memory capable of setting a locking state for inhibiting data writing with respect to at least a predetermined area in the memory;

detection means for detecting state of the expendable;

write means for writing result detected by said detection means to the memory; and

locking state control means for controlling the locking state of the memory on the basis of the result of said expendable detected by detection means.

8. The apparatus according to claim 7, wherein the data communication between said printer and said expendable is made by wireless.

9. The apparatus according to claim 7, wherein said detection means detects an amount of an expendable agent in the expendable.

10. The apparatus according to claim 7, wherein, when the amount of the expendable agent in the expendable detected by said detection means reaches a predetermined amount or one of a plurality of predetermined amounts said write means, said write means writes data, indicating that the amount of expendable agent has reached to the predetermined amounts, in said area of said memory, and said lock state control means controls the memory so that the area of the memory becomes locked state.

11. A method of controlling a printing apparatus to which an expendable having a memory for storing and holding information that pertains to a use state and a recording agent used in a print process is detachably attached, comprising:

the memory access step of making read and write to the memory in the expendable; and

the setting step of setting inhibition/permission of data write with respect to an address space in the memory.

12. The method according to claim 11, wherein data communication with said memory in said memory access step is performed by using a serial communication line.

13. The method according to claim 11, wherein data communication with said memory in said memory access step is performed in non-contact manner with said memory.

14. The method according to claim 11, further comprising the detection step of detecting a mount of expendable agent in said expendable,

wherein, in said memory access step, the amount of the expendable agent in said expendable is written to a predetermined address of said memory,

and in said setting step, when the amount of the expendable agent detected in said detection step is less than a predetermined amount, write to the predetermined address of said

memory is set to be inhibited.

15. The method according to claim 11, wherein one or a plurality of predetermined amounts of the expendable agent are determined in advance, when each of the predetermined amounts has been reached, data indicating that the predetermined amount has been reached is written in an address area corresponding to that predetermined amount at a different timing, and write to the address area is set to be inhibited.

16. The method according to claim 11, wherein said memory has a management address area for storing information indicating that write to an address area for storing a use state is inhibited or permitted, wherein, in said setting step, the setting inhibition/permission of data write is performed against to the management address area.

17. A method of controlling a printing apparatus having detaching/attaching means for detaching or attaching an expendable having a memory capable of setting a locking state for inhibiting data writing with respect to a predetermined area in the memory, comprising the steps of:

the detection step of detecting state of the expendable;
the write step of writing result detected in said detection step to the memory; and
the locking state control step of controlling locking state of the memory on the basis of the status of the expendable detected in said detection step.

18. The method according to claim 17, wherein data communication between the printing apparatus and the memory is made by wireless.

19. The method according to claim 17, wherein, in said detection step, an expendable agent in the expendable is detected.

20. The method according to claim 17, wherein, when the amount of the expendable agent in the expendable detected in said detection step reaches a predetermined amount or one of a plurality of predetermined amounts, data indicating that the amount of expendable agent has reached to the predetermined amount is written in an area of said memory in said write step, and, in said lock state control step, said memory is controlled so that the area of the memory becomes locked state.

21. An expendable which has a recording agent used in a print process and is detachable from a printing apparatus, comprising:

communication means for communicating with the printing apparatus when said expendable is attached to the printing apparatus;
a memory for storing and holding information that pertains to a use state, and writing and reading out data via said communication means when said expendable is attached to the printing apparatus; and
means for receiving information indicating permission/inhibition of write to said memory in units of addresses via said communication means, and locking write to said memory.

22. The expendable according to claim 21, wherein said communication means is means for communicating with the printer via a serial communication line.

23. The expandable according to claim 21, wherein said communication means is means for communicating with the printer by wireless.

24. The expendable according to claim 21, wherein said memory has an address area for storing an amount of expendable agent in the expendable, wherein, when the amount of the expendable agent in the expendable is less than a predetermined amount or one of a plurality of predetermined amounts, write to the address area of said memory is set to be inhibited.

25. The expendable according to claim 21, wherein said memory has address areas corresponding to a plurality of predetermined amounts of expendable agent, when the amount of expendable agent in the expendable reaches a predetermined amount, data indicating that the amount of expendable agent reaches the predetermined amount is written to an address area corresponding to the predetermined amount, and write to the written address area is set to be inhibited.

26. The expendable according to claim 21, wherein said memory has a management address area for storing information indicating that write to an address area for storing a use state is inhibited or permitted.

FIG. 1

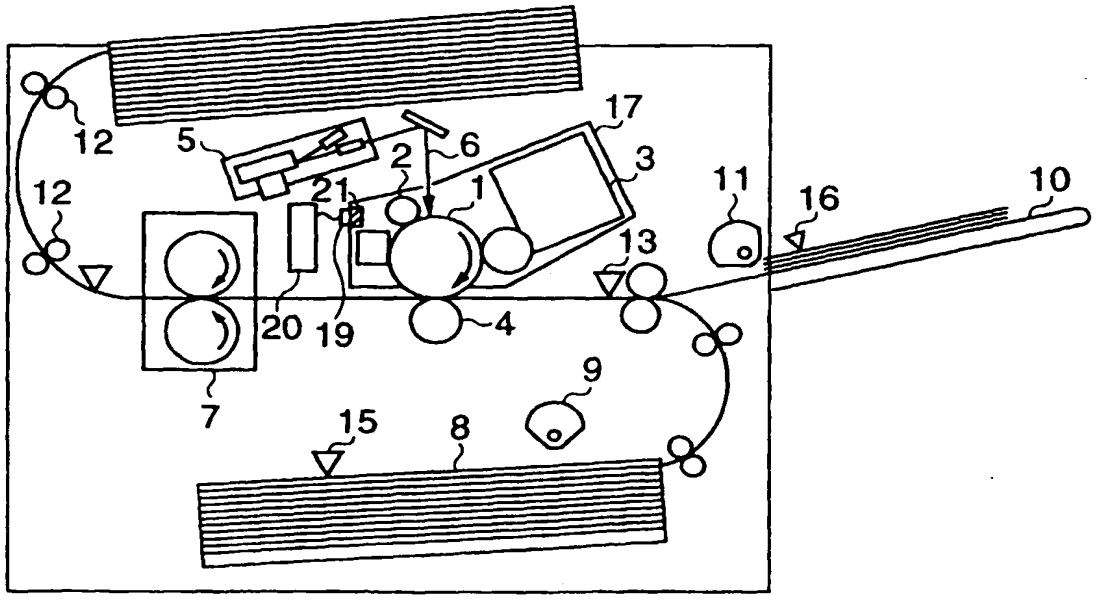
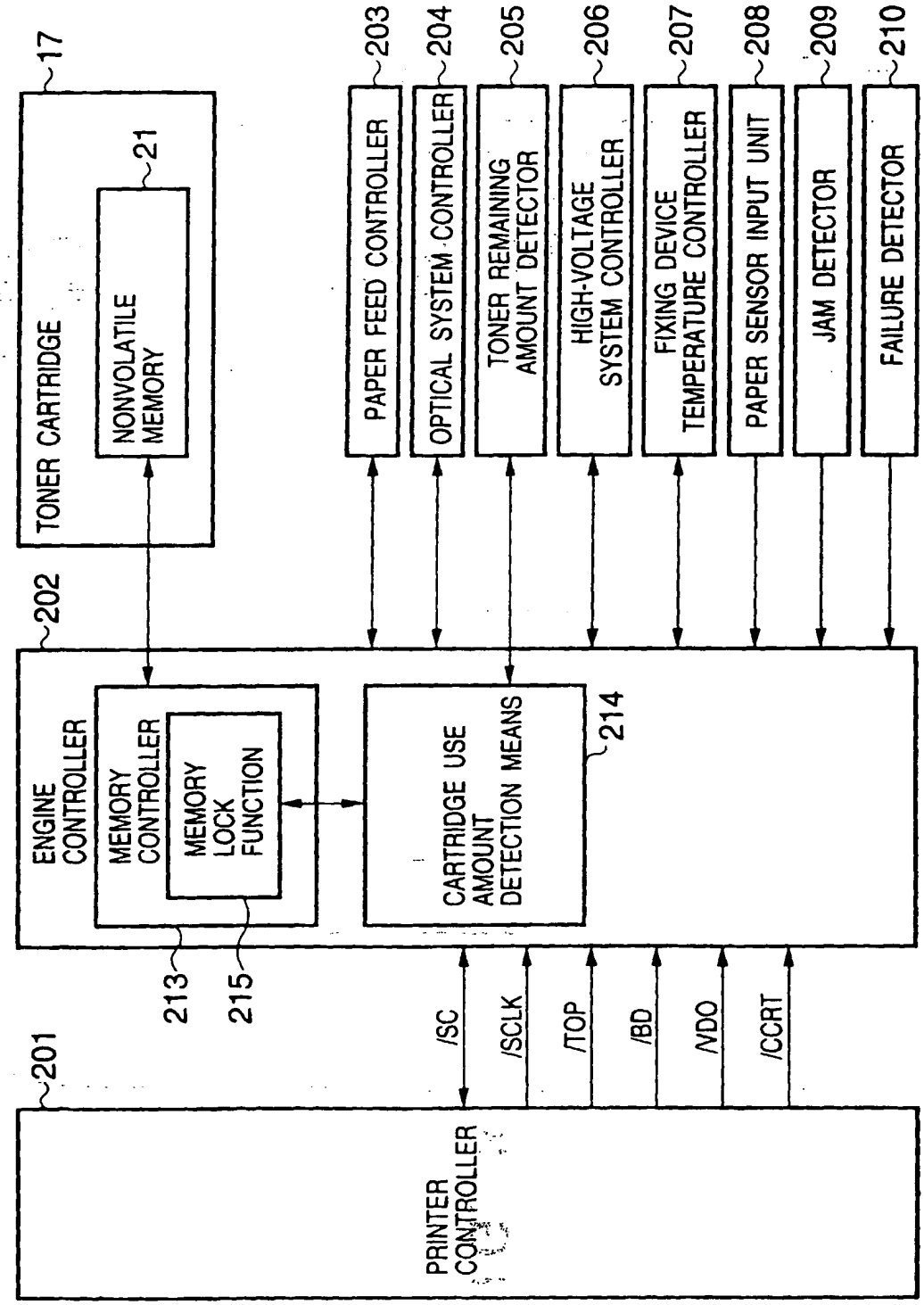


FIG. 2


17
TONER CARTRIDGE
21
NONVOLATILE MEMORY
202
ENGINE CONTROLLER
MEMORY CONTROLLER
MEMORY LOCK FUNCTION
CARTRIDGE USE AMOUNT DETECTION MEANS
214
213
215
201
PRINTER CONTROLLER
/SC
/SCLK
/TOP
/BD
/VDO
/CCRT
203
PAPER FEED CONTROLLER
204
OPTICAL SYSTEM CONTROLLER
205
TONER REMAINING AMOUNT DETECTOR
206
HIGH-VOLTAGE SYSTEM CONTROLLER
207
FIXING DEVICE TEMPERATURE CONTROLLER
208
PAPER SENSOR INPUT UNIT
209
JAM DETECTOR
210
FAILURE DETECTOR

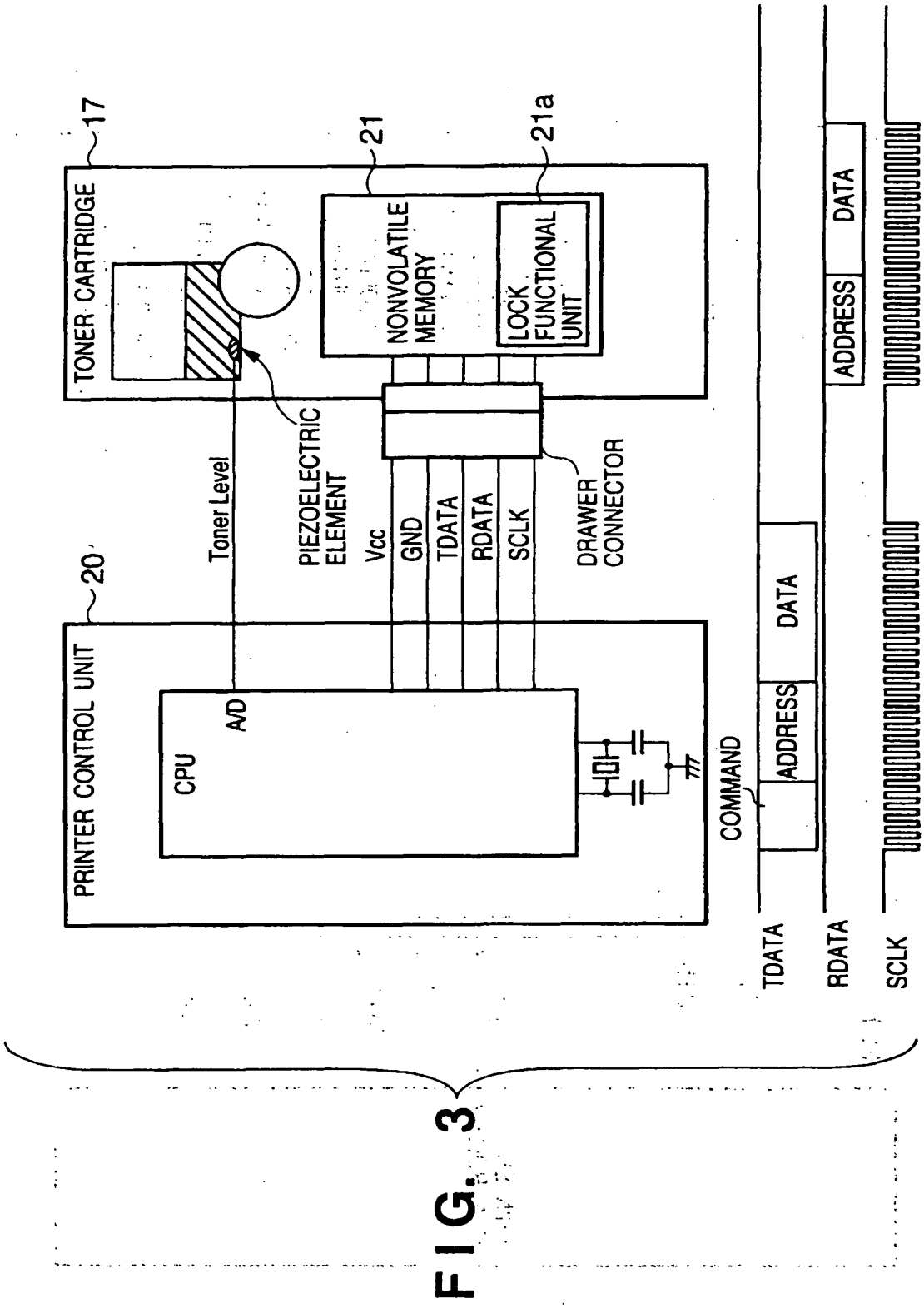

TONER CARTRIDGE
17
21
21a
NONVOLATILE MEMORY
LOCK FUNCTIONAL UNIT
PIEZOELECTRIC ELEMENT
Toner Level
Vcc
GND
TDATA
RDATA
SCLK
DRAWER CONNECTOR
PRINTER CONTROL UNIT
20
CPU
A/D
COMMAND
ADDRESS
DATA
ADDRESS
DATA
TDATA
RDATA
SCLK

FIG. 3

FIG. 4

ADDRESS NO.	ADDRESS	CONTENTS
1	000	MANUFACTURING NO. (LOT NO.) OF CARTRIDGE
2	001	UNUSED
3	010	UNUSED
4	011	UNUSED
5	100	CARTRIDGE TONER REMAINING AMOUNT
6	101	CARTRIDGE SERVICE LIFE EXPIRE INFORMATION
7	110	LOCK SETUP FOR ADDRESS NOS. 1 TO 4
8	111	LOCK SETUP FOR ADDRESS NOS. 5 TO 8

FIG. 5

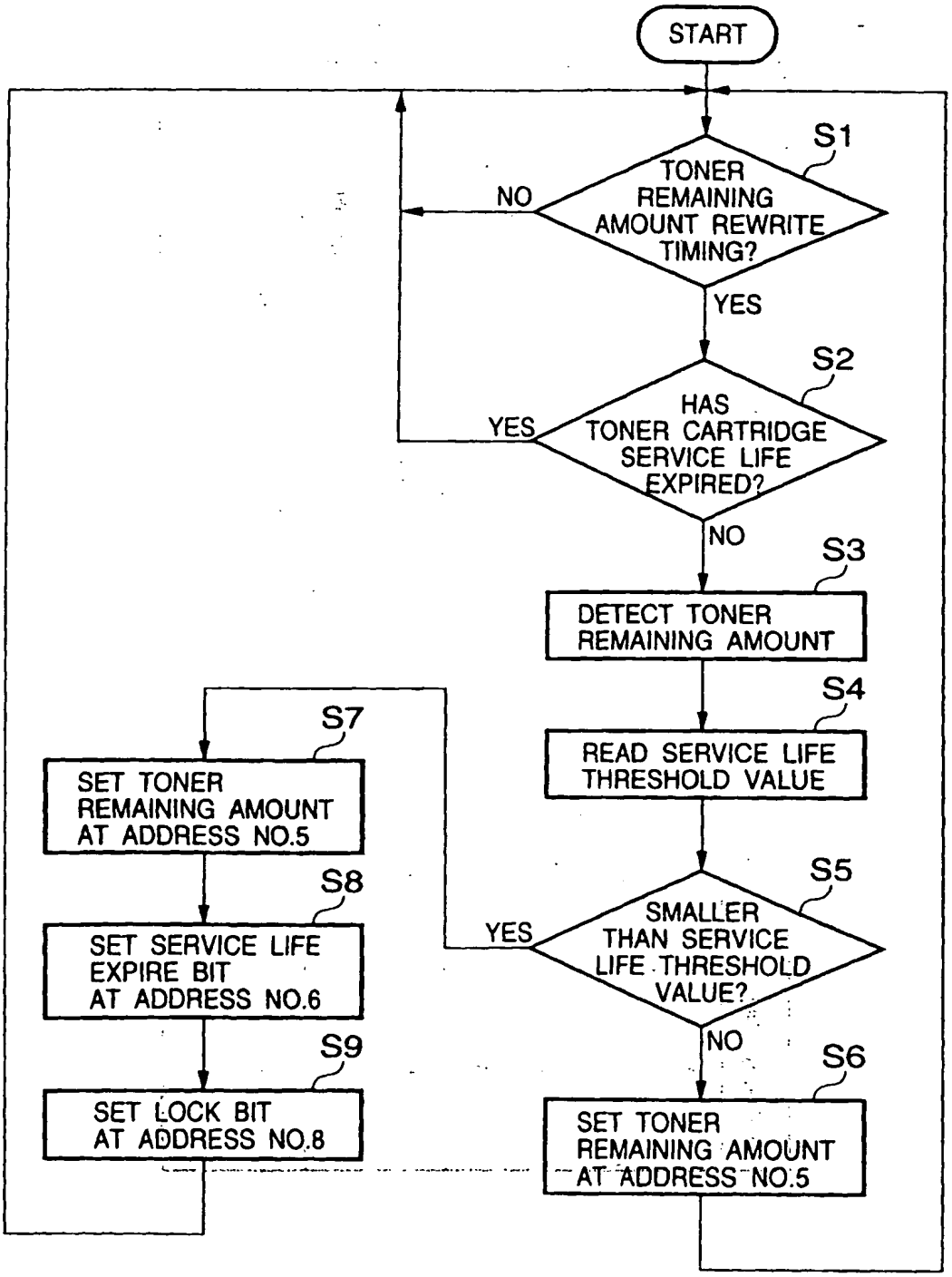

START
S1
TONER REMAINING AMOUNT REWRITE TIMING?
NO
YES
S2
HAS TONER CARTRIDGE SERVICE LIFE EXPIRED?
YES
NO
S3
DETECT TONER REMAINING AMOUNT
S4
READ SERVICE LIFE THRESHOLD VALUE
S5
SMALLER THAN SERVICE LIFE THRESHOLD VALUE?
YES
NO
S6
SET TONER REMAINING AMOUNT AT ADDRESS NO.5
S7
SET TONER REMAINING AMOUNT AT ADDRESS NO.5
S8
SET SERVICE LIFE EXPIRE BIT AT ADDRESS NO.6
S9
SET LOCK BIT AT ADDRESS NO.8

FIG. 6

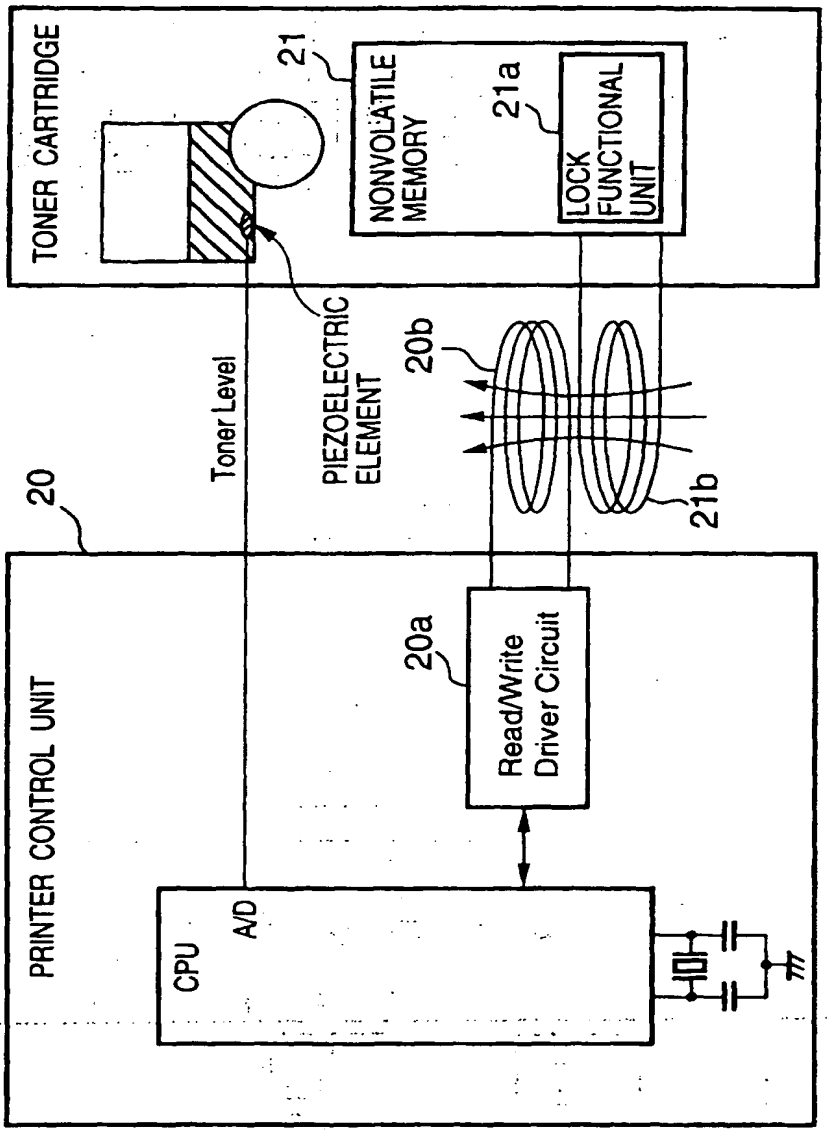

TONER CARTRIDGE
21
NONVOLATILE MEMORY
21a
LOCK FUNCTIONAL UNIT
PIEZOELECTRIC ELEMENT
Toner Level
20b
21b
20
20a
Read/Write Driver Circuit
PRINTER CONTROL UNIT
CPU
A/D

FIG. 7

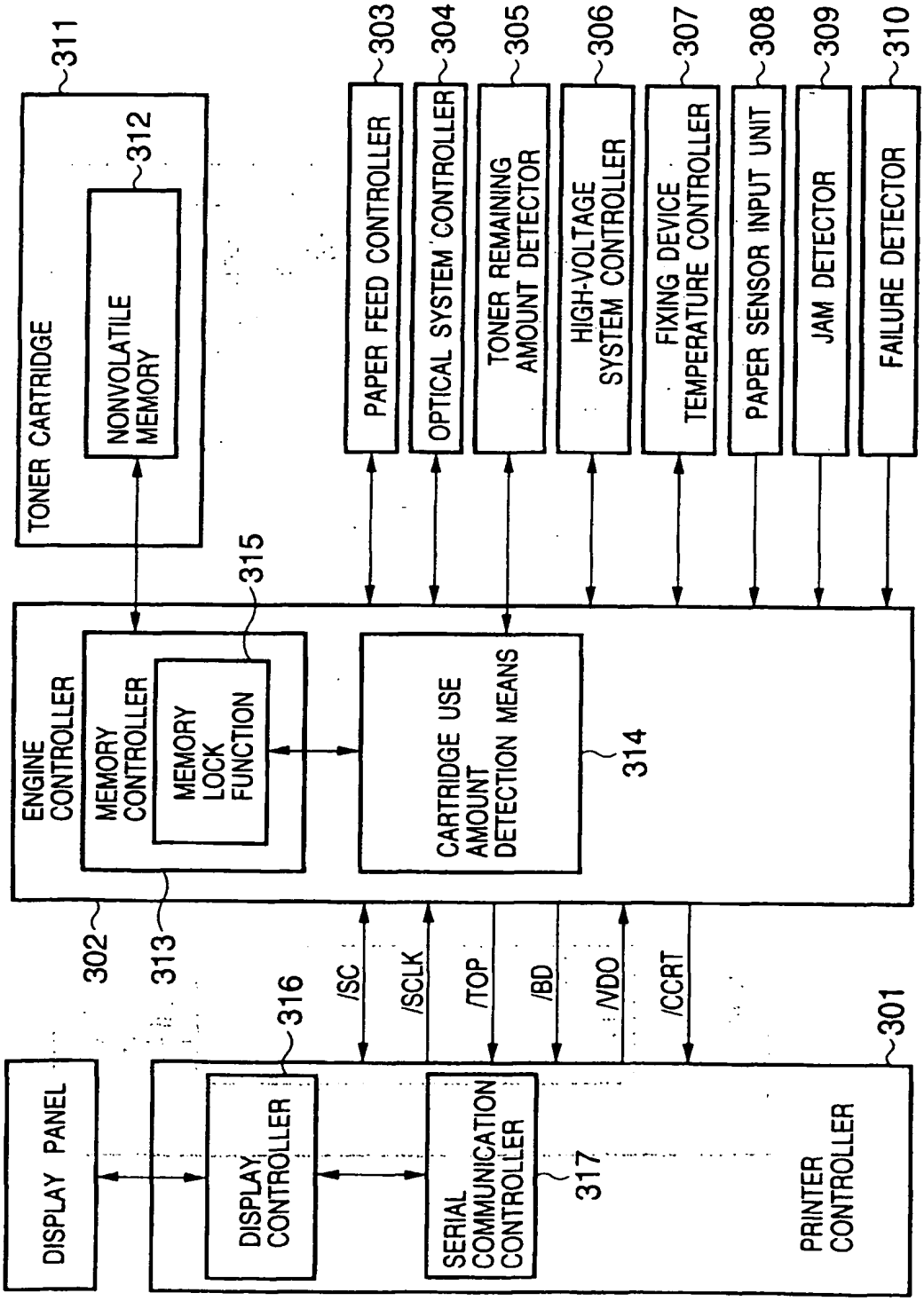
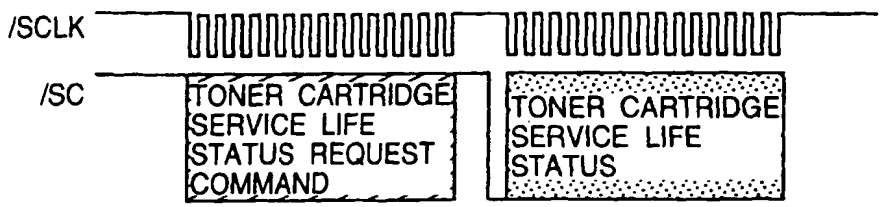

TONER CARTRIDGE
311
NONVOLATILE MEMORY
312
315
ENGINE CONTROLLER
MEMORY CONTROLLER
MEMORY LOCK FUNCTION
CARTRIDGE USE AMOUNT DETECTION MEANS
314
302
313
316
301
PAPER FEED CONTROLLER
303
OPTICAL SYSTEM CONTROLLER
304
TONER REMAINING AMOUNT DETECTOR
305
HIGH-VOLTAGE SYSTEM CONTROLLER
306
FIXING DEVICE TEMPERATURE CONTROLLER
307
PAPER SENSOR INPUT UNIT
308
JAM DETECTOR
309
FAILURE DETECTOR
310
/SC
/SCLK
/TOP
/BD
/VDO
/CCRT
DISPLAY PANEL
DISPLAY CONTROLLER
SERIAL COMMUNICATION CONTROLLER
317
PRINTER CONTROLLER

FIG. 8



TONER CARTRIDGE SERVICE LIFE STATUS

BIT	CONTENTS
1st BIT	0
2nd BIT	TONER CARTRIDGE SERVICE LIFE EXPIRE BIT
3rd BIT	UNKNOWN
4th BIT	UNKNOWN
5th BIT	UNKNOWN
6th BIT	UNKNOWN
7th BIT	UNKNOWN
8th BIT	PRINT COMMAND CODE 2^7
9th BIT	PRINT COMMAND CODE 2^6
10th BIT	PRINT COMMAND CODE 2^5
11th BIT	PRINT COMMAND CODE 2^4
12th BIT	PRINT COMMAND CODE 2^3
13th BIT	PRINT COMMAND CODE 2^2
14th BIT	PRINT COMMAND CODE 2^1
15th BIT	PRINT COMMAND CODE 2^0
16th BIT	ODD PARITY BIT

FIG. 9

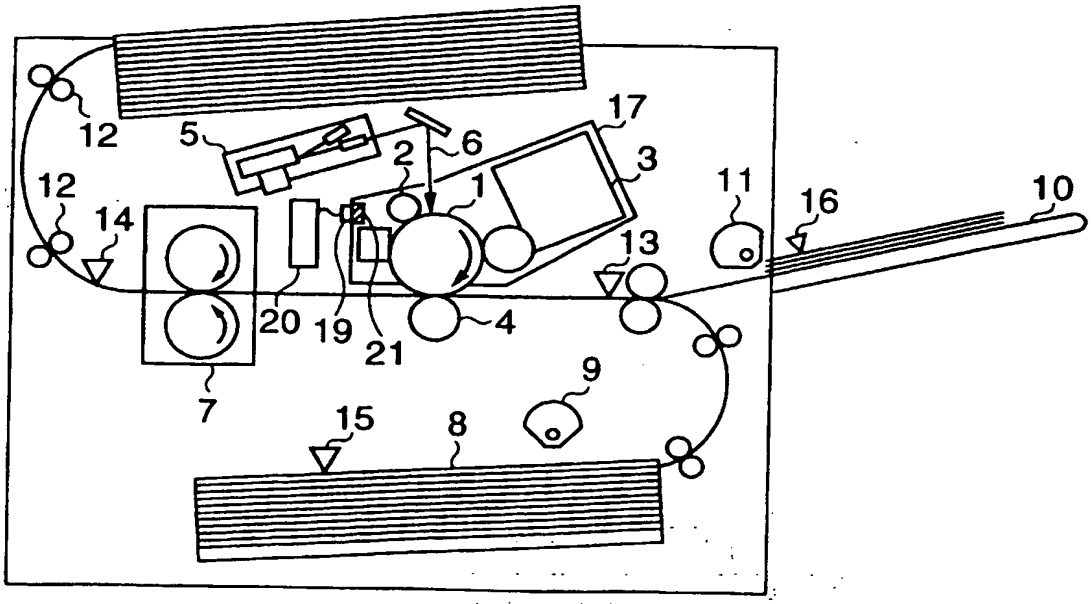
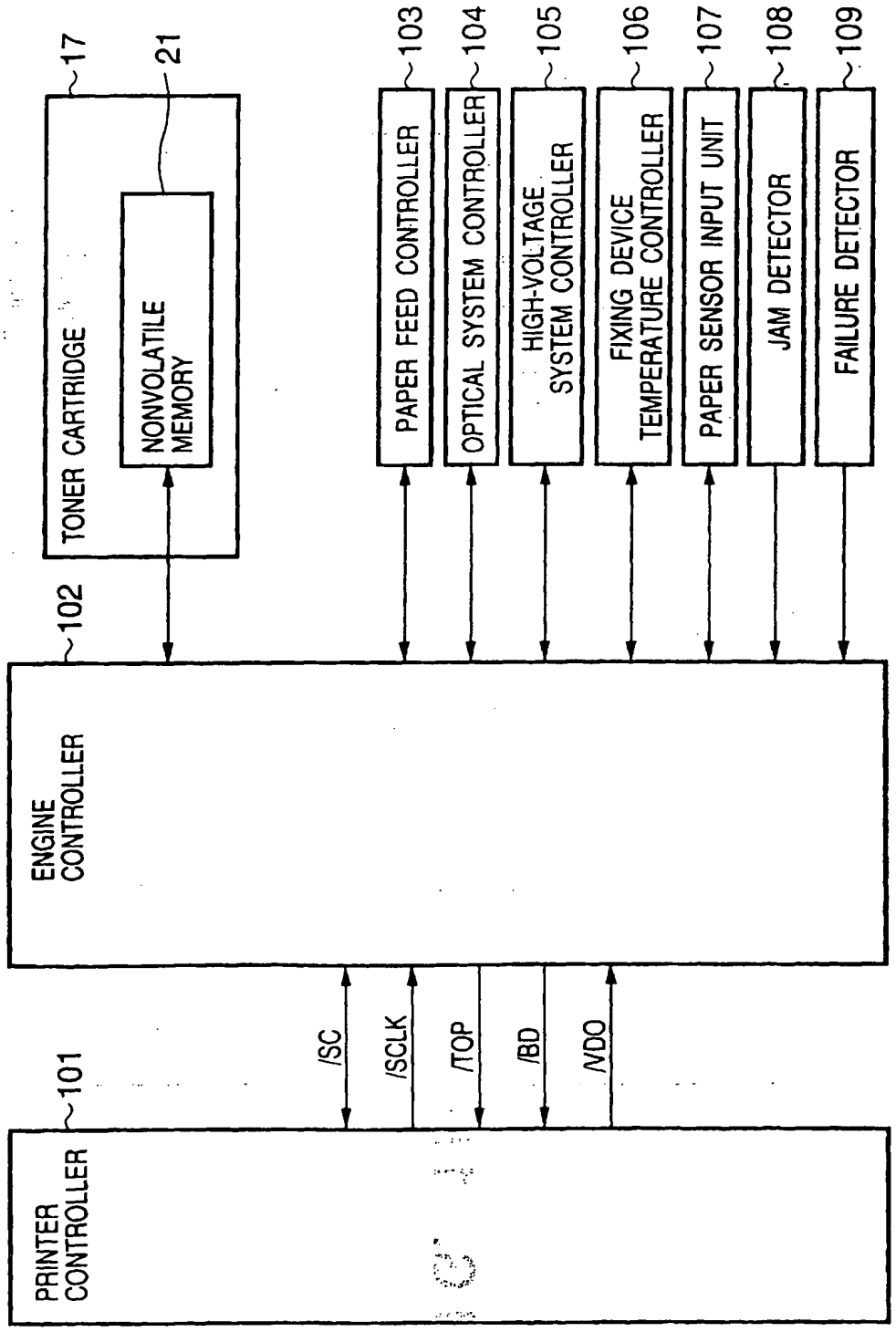


FIG. 10


PRINTER CONTROLLER
101
ENGINE CONTROLLER
102
/SC
/SCLK
/TOP
/BD
/VDO
TONER CARTRIDGE
17
NONVOLATILE MEMORY
21
PAPER FEED CONTROLLER
103
OPTICAL SYSTEM CONTROLLER
104
HIGH-VOLTAGE SYSTEM CONTROLLER
105
FIXING DEVICE TEMPERATURE CONTROLLER
106
PAPER SENSOR INPUT UNIT
107
JAM DETECTOR
108
FAILURE DETECTOR
109

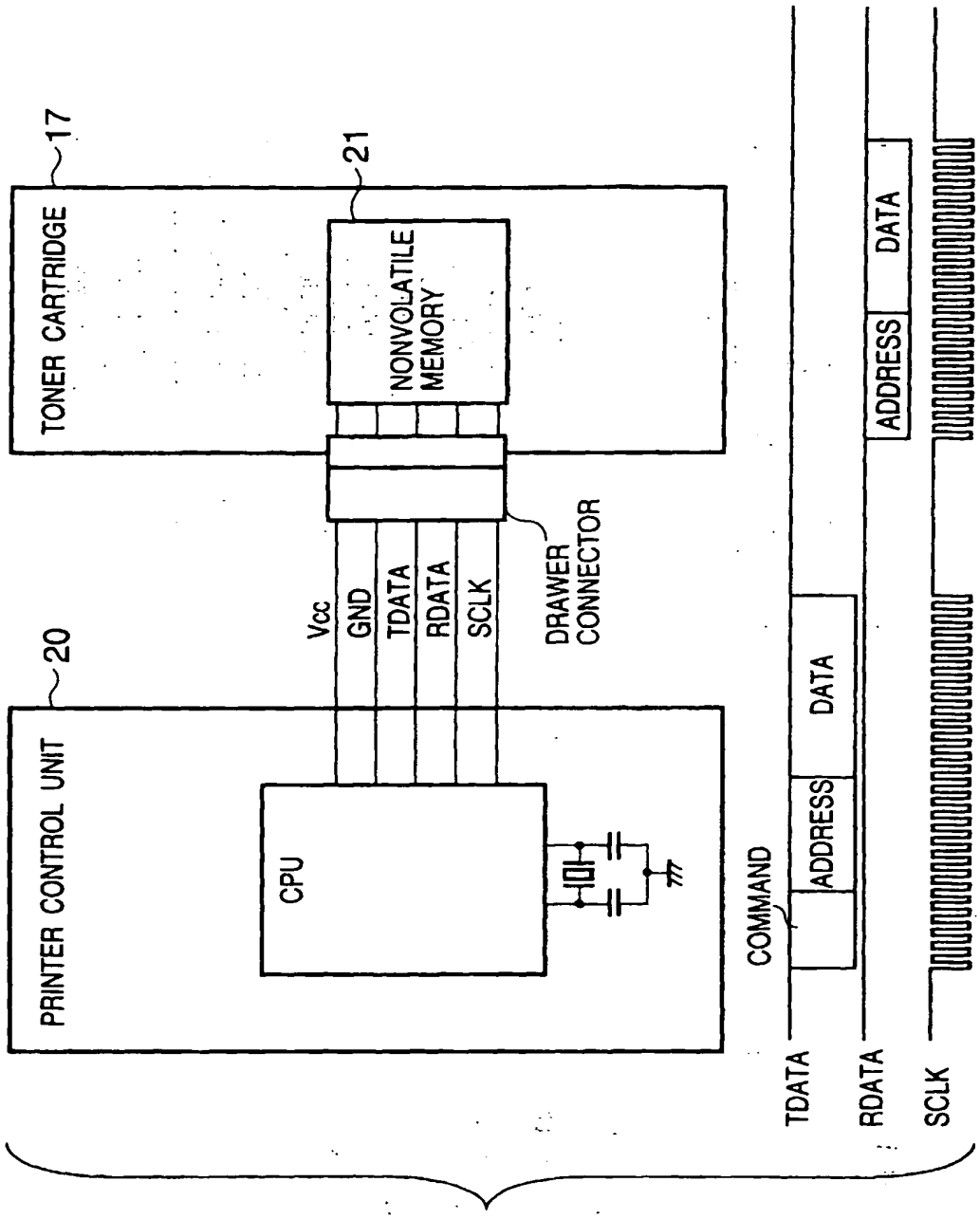

TONER CARTRIDGE
17
21
NONVOLATILE MEMORY
DRAWER CONNECTOR
Vcc
GND
TDATA
RDATA
SCLK
20
PRINTER CONTROL UNIT
CPU
COMMAND
ADDRESS
DATA
ADDRESS
DATA
TDATA
RDATA
SCLK

FIG. 11

FIG. 12

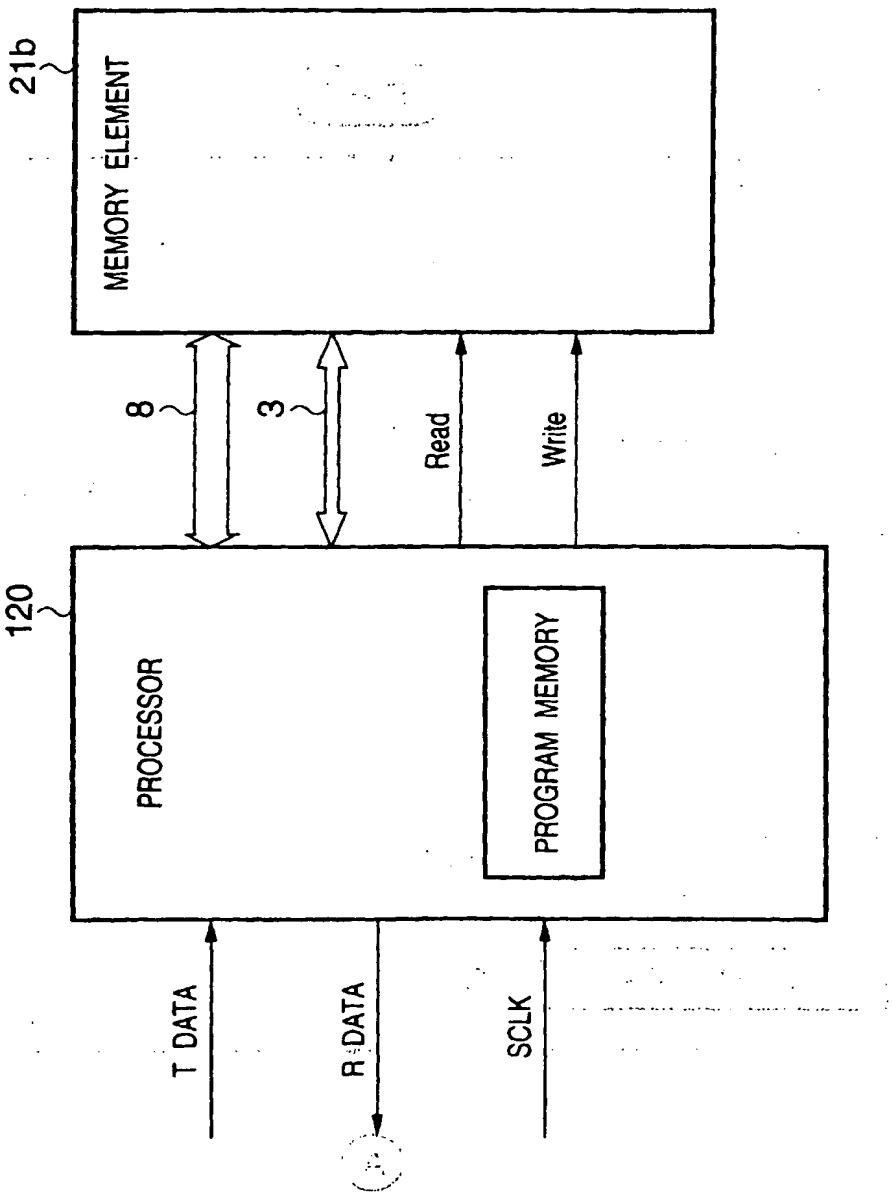

21b
MEMORY ELEMENT
8
3
Read
Write
120
PROCESSOR
PROGRAM MEMORY
T DATA
R DATA
SCLK

FIG. 13

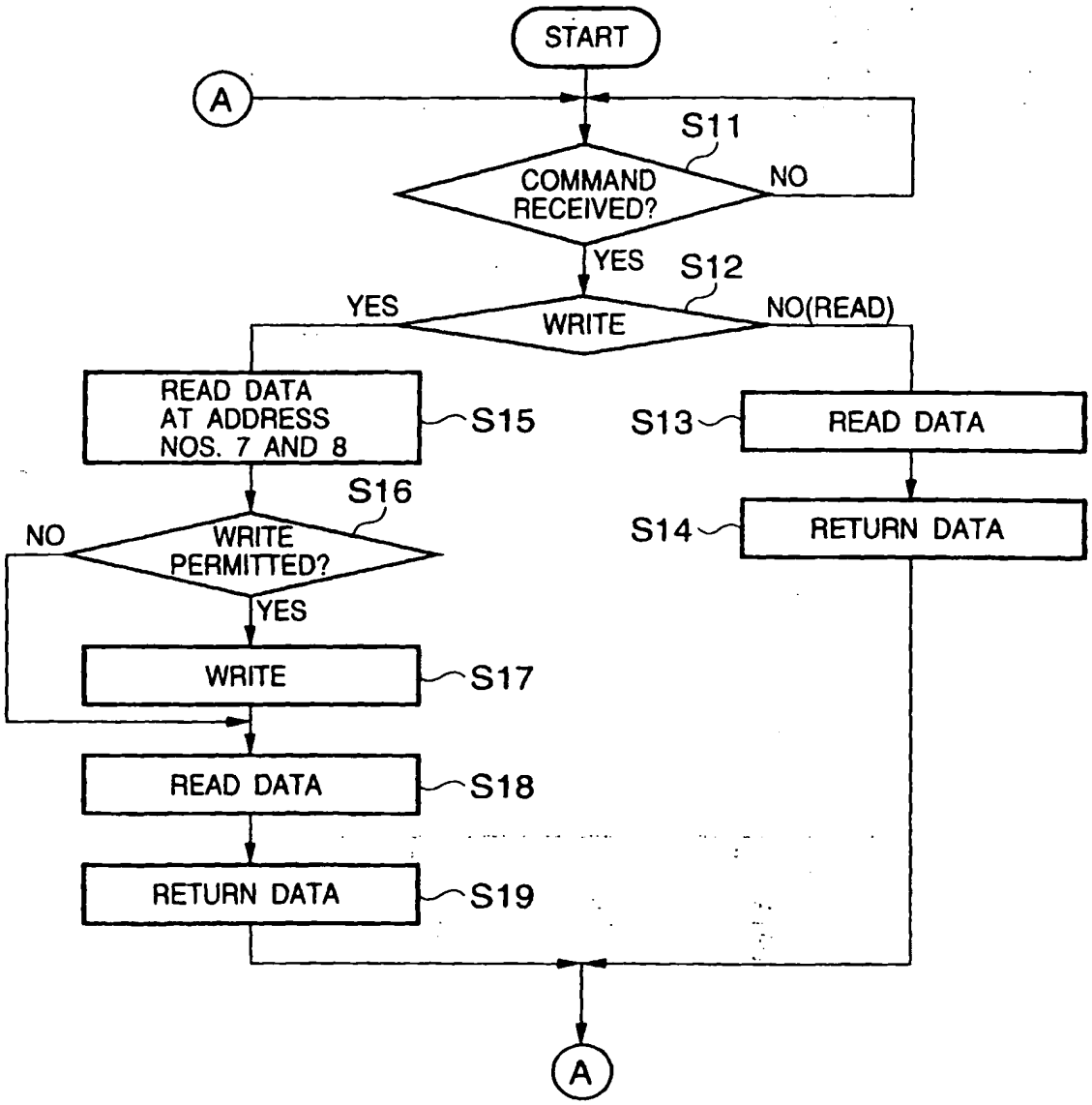

START
A
S11
COMMAND RECEIVED?
NO
YES
S12
WRITE
YES
NO(READ)
READ DATA AT ADDRESS NOS. 7 AND 8
S15
S13
READ DATA
S16
NO
WRITE PERMITTED?
S14
RETURN DATA
YES
WRITE
S17
READ DATA
S18
RETURN DATA
S19
A

FIG. 14

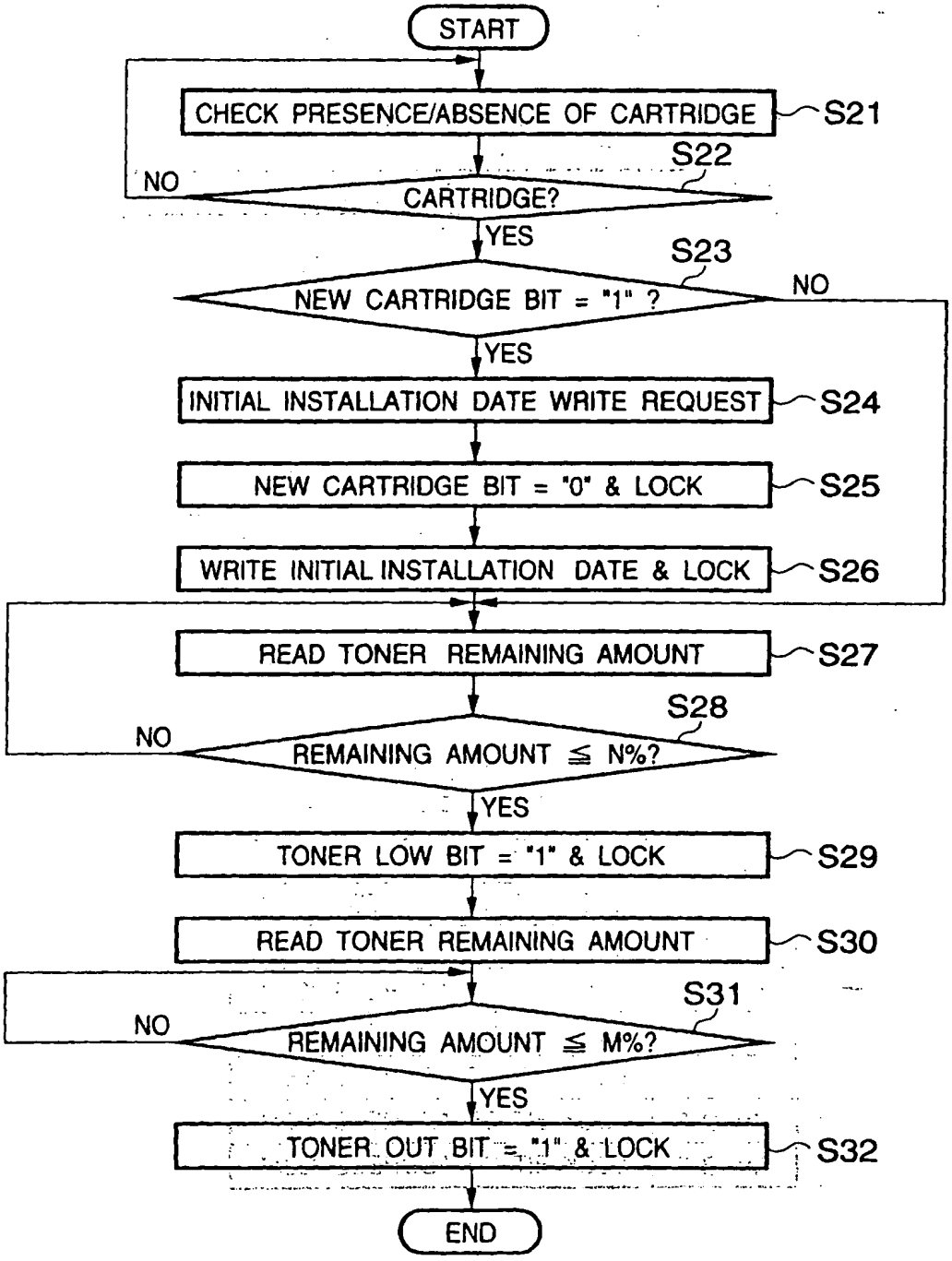

START
CHECK PRESENCE/ABSENCE OF CARTRIDGE
S21
S22
NO
CARTRIDGE?
YES
S23
NEW CARTRIDGE BIT = "1" ?
NO
YES
INITIAL INSTALLATION DATE WRITE REQUEST
S24
NEW CARTRIDGE BIT = "0" & LOCK
S25
WRITE INITIAL INSTALLATION DATE & LOCK
S26
READ TONER REMAINING AMOUNT
S27
S28
NO
REMAINING AMOUNT ≦ N%?
YES
TONER LOW BIT = "1" & LOCK
S29
READ TONER REMAINING AMOUNT
S30
S31
NO
REMAINING AMOUNT ≦ M%?
YES
TONER OUT BIT = "1" & LOCK
S32
END

FIG. 15

ALL ADDRESS AREAS OF MEMORY
(EACH 8BIT DATA)

ADDRESS	CONTENT
01h	NEW CARTRIDGE
02h	INITIAL INSTALLATION DATE
03h	TONER LOW
04h	TONER OUT
05h	RESERVED
06h	RESERVED
~	~
FDh	PAGE COUNT (UNLOCKED AREA)
FEh	USED AMOUNT OF DRUM CARTRIDGE (UNLOCKED AREA)
FFh	LOCK BIT AREA

THE CONTENT OF ADDRESS "FFh"

BIT	CONTENT
1st BIT	LOCK BIT OF ADDRESS "01h"
2nd BIT	LOCK BIT OF ADDRESS "02h"
3rd BIT	LOCK BIT OF ADDRESS "03h"
4th BIT	LOCK BIT OF ADDRESS "04h"
5th BIT	LOCK BIT OF ADDRESS "05h"
6th BIT	LOCK BIT OF ADDRESS "06h"
7th BIT	LOCK BIT OF ADDRESS "07h"
8th BIT	LOCK BIT OF ADDRESS "08h"

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